**JUSTIFYING VACCINE ALLOCATION TO POPULATIONS WITH HIGH CONTACT RATES**

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AUTHORS:

Stephen Kissler ([skissler@hsph.harvard.edu](mailto:skissler@hsph.harvard.edu))

Rebecca Kahn

COMPILED FOR:

Partners in Health

EXECUTIVE SUMMARY:

**CONTEXT**

The COVID-19 pandemic has caused 28.4 million recorded infections and 508,000 deaths in the United States as of February 26th, 2021. Rates of COVID-19 mortality and severe disease have been especially high in elderly and minority populations. Two COVID-19 vaccines have been authorized for emergency use in the United States. According to a recent mathematical modeling study, the optimal mortality-minimizing vaccination strategy is to prioritize vaccination for those at highest risk of severe disease.1 In practice, this has led policymakers to prioritize vaccine doses by age because the risk of severe disease increases sharply with age, and insufficient data exist to inform disease transmission models based on other social and demographic factors. However, due to differences in life expectancy between racial/ethnic groups, age-based vaccine prioritization has contributed to racial/ethnic disparities in vaccination rates. Furthermore, members of racial/ethnic minority groups disproportionately hold essential jobs that require frequent interpersonal contacts, raising their risk of both acquiring and transmitting SARS-CoV-2. This underscores the potential value of prioritizing these populations for vaccination. Vaccine uptake among 75+ year-olds has reached \_\_% in the United States, thereby protecting many of the most vulnerable individuals. It is now an urgent priority to consider whom to vaccinate next. This choice should be informed by a wide range of considerations including justice, reciprocity, and anticipated epidemiological outcomes. This report considers the epidemiological angle.

**APPROACH**

**Defining contact rates.**

Many epidemiological models assume that contact rates are either constant or Poisson-distributed among members of a population. However, empirical studies indicate that true interpersonal contact rates exhibit wider variation than either of these standard choices. In the *BBC Pandemic* study,2 for example, the number of daily contacts in the population follows a negative binomial distribution with size = 1.68 and mean = 10.47 (Fig. 1). We adopted this daily interpersonal contact rate for the vaccine prioritization model.

Histogram

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**Figure 1.** Daily contact rate as measured by the BBC Pandemic study. The best-fit negative binomial distribution has size = 1.68 and mean = 10.47.

**Defining mortality risk.**

We used the age-related distribution of IFR and the population structure of the US to estimate the risk of death given infection for each person in the simulation.

Currently the model takes no account of any association between mortality risk and contact rate.

**Defining the vaccination strategy.**

Vaccination is assumed to start on a given day (default day = 15) and to proceed at a rate of 0.2% of the population per day.3 The user can input the vaccine efficacy for blocking death (default = 95%), blocking transmission (default = 50%), and blocking infection (default = 50%). It is possible to prioritize vaccination based on risk of death, contact rate, or at random. The strategy is allowed to switch once certain percentages of the population have been vaccinated. The default strategy is to vaccinate the highest-risk individuals until 10% of the population has been vaccinated, then to vaccinate the highest-contact individuals until 60% of the population has been vaccinated. Vaccination ends after 60% uptake to model vaccine hesitancy.

**Running the simulation.**

At the beginning of the simulation, we produce a network that is consistent with the negative binomial contact rate. This network stays fixed throughout the simulation. In a sensitivity analysis, we allow the network to change every day.

In each simulated day, the model proposes a new set of individuals to enter the “exposed” category, the “infectious” category and the “recovered/removed” category. Among the individuals who enter the “recovered/removed” category, deaths are sampled according to each person’s IFR.

**RESULTS**

A) B)

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**Figure 2.** Vaccination strategies 1 and 2 include no transmission/infection reduction. Strategies 3 and 4 include 50% reduction in transmission and infection. Strategies 1 and 3 switch from prioritizing morbidity to prioritizing contact rates at 10% of the population vaccinated. Strategies 2 and 4 switch at 50% of the population vaccinated.

**REFERENCES**

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